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Focus. . . Smoking During Pregnancy: Missouri Longitudinal Study

Maternal smoking during pregnancy has been shown to be associated with reduced birth weight and increased fetal and infant mortality. This paper examines these patterns in first and second maternally linked singleton pregnancies from 1978 to 1990 among 176,843 Missouri resident women with known smoking status in both pregnancies.

Methods

The original Missouri linked data set was developed by linking higher-order live births and fetal deaths from 1978 to 1990 to lower-order live births and fetal death reports using probabilistic linkage procedures.

From this sibship file, 184,483 linked first- and second-order singleton pregnancies (live births and fetal deaths greater than or equal to 20 weeks; gestation) for Missouri resident women were extracted. This represented 86.8 percent of the attempted linkages in which the targeted first birth was a live birth. There was little difference in match rates by demographic characteristics (race, marital status, birth weight). Maternal smoking status was available for both pregnancies for 176,843 of these sibships (95.9 percent), which represented the final study sample.

Results

More of the Missouri women in this study smoked cigarettes during their second pregnancy (27.4 percent) than during the first (25.8 percent). As Table 1 shows 21.5 percent of women smoked in both first and second pregnancies and 68.4 percent did no t smoke in either pregnancy. While 4.3 percent of the study mothers smoked in their first pregnancy only 5.9 percent smoked in the second pregnancy only.

The pattern of increased smoking in the second pregnancy is strongest for mothers who were under age 20 in their first pregnancy. About 6.2 percent more of these mothers smoked in the second pregnancy than in the first (34.6 percent in first vs. 40.8 p ercent in second). Conversely for women aged 20 or more in the first pregnancy there was little difference in the smoking rates between the first and second pregnancies (22.0 percent vs. 21.8 percent respectively). Black women in their second pregnancy ha d a smoking rate of 29.0 percent or 4.8 percent more than in their first pregnancy. For non-black women the difference was just 1.1 percent (26.0 percent in the first vs. 27.1 percent in the second).

Table 1 shows that the pattern of increased smoking in the second pregnancies is stronger by age than by race. For both black and non-black women there were substantial increases in smoking in the second pregnancy for women under age 20 in the first. F or women aged 20 or more years in the first pregnancy there was little change in the rate of smoking between pregnancies regardless of race. Table 1 also shows much higher smoking rates for non-black women under age 20 in the first pregnancy than black wo men which is the opposite of the pattern or women ages 20 or more.

One exception to the increased smoking in the second pregnancy is for women who experienced a fetal or infant death in the first pregnancy. For these women, more stopped smoking by the second pregnancy (7.3 percent) than those women who did not experie nce a death in the first pregnancy (4.2 percent). The smoking rate for women experiencing a death in the first pregnancy was 30.7 percent in the second pregnancy compared with 32.4 percent in the first. This pattern of reduced smoking in the second pregna ncy did not quite hold for women with a low birth weight infant in the first pregnancy (39.5 percent in first vs. 40.2 percent in second).

Birth weight in the second pregnancy was highly correlated with smoking status in the second pregnancy regardless of smoking status in the first pregnancy. The mean birth weight after adjustment for covariates in the second pregnancy for infants of mot hers who smoked in both pregnancies was 3,280 grams (95 percent confidence interval 3,275-3,285 grams) or 185 grams less than infants of mothers who smoked in neither pregnancy (3,465 $\pm$ 3 grams). Infants of mothers who smoked in the second pregnanc y only weighed an average of 3,303 $\pm$ 10 grams, while infants of mothers who smoked in the first pregnancy only weighed the most at 3,489 $\pm$ 11 grams.

As Table 2 shows, mothers who smoked in the second pregnancy had infants with second order adjusted low birth weight (LBW) and small for gestational age (SGA) rates approximately double those not smoking in the second pregnancy, regardless of smoking s tatus in the first pregnancy. Smoking was more strongly associated with SGA rates than with LBW rates. For those smoking in both pregnancies the relative risk (RR) for SGA was 2.31 and 1.87 for LBW compared with infants of mothers smoking in neither pregn ancy.

The adjusted RRs of smoking in both pregnancies to not smoking in both pregnancies were 1.19 for fetal death 1.37 for neonatal death and 1.90 for postneonatal death. Smoking in the second pregnancy but not the first was associated with a significant ad justed RR of 1.60 for postneonatal death.

Table 3 presents the RRs of levels of smoking in first and second pregnancies to not smoking in either pregnancy for LBW SGA and perinatal mortality. Generally there was a close relationship of smoking level in the second pregnancy to pregnancy outcome s in the second pregnancy. Infants of mothers who smoked at least one pack of cigarettes per day had adjusted RRs for LBW and SGA of more than two to one compared with non-smoking pregnancies regardless of smoking level in the first pregnancy. Pregnancies involving mothers who reduced their smoking level from one or more packs per day in the first pregnancy to less than a pack per day in the second pregnancy had similar RRs for SGA and LBW to those smoking a pack or more per day in the second pregnancy. T he two other groups of mothers smoking less than a pack per day in the second pregnancy had RRs of LBW and SGA between 1.65 and 2.05. Infants of mothers who stopped smoking by the second pregnancy had RRs for LBW and SGA in the second pregnancy between 0. 95 and 1.24.

The RRs of amount smoked to fetal and neonatal mortality were again much lower than for LBW and SGA. The group with the highest adjusted RR of 1.79 for fetal mortality was for those mothers who did not smoke in the first pregnancy, but smoked a pack or more per day in the second pregnancy. The group with the highest adjusted RR for neonatal death was for women who reduced their smoking level in the second pregnancy, but did not stop (1.65). Significant adjusted RRs for postneonatal death were found for five of the six categories involving smoking in the second pregnancy.

Discussion

The results of this longitudinal maternally-linked pregnancy among Missouri women generally support the findings in the numerous cross-sectional smoking in pregnancy studies. As Stockbauer and Land found1 , m ore mothers smoked in their second pregnancy than in the first. This longitudinal study provides evidence that this is because more started by the second pregnancy after not smoking in the first than those who stopped by t he second pregnancy after smoking in the first.

Also as with the cross-sectional studies, smoking in the second pregnancy was associated with a decreased birth weight of nearly 200 grams and a doubling of the risk for LBW and SGA. The relationship was stronger for SGA than LBW as smoking apparently affects birth weight more than gestational age. Perinatal mortality was increased by nearly 30 percent among smoking-related pregnancies. This longitudinal study showed that mothers who smoked in the first pregnancy but did not smoke in the second have th e same or lesser risk of a negative pregnancy outcome as those who did not smoke in either pregnancy. Therefore stopping smoking between pregnancies is clearly beneficial.

However, despite the obvious benefits of smoking cessation, most women who smoked in the first pregnancy also smoked in the second, and a large percentage smoked in the second after abstaining in the first. This occurred in spite of the general decline in smoking rates during the 13 years of this study and the fact that there was an average of 3 years between pregnancies in this study. Possible reasons for the increased smoking in the second pregnancy, especially among teenagers, may be underreporting of smoking in the first pregnancy or the possibility that teen pregnancy may be a precursor to substance abuse including cigarette smoking. The type of risky behavior that leads to teen pregnancy may be the same type that leads to smoking.

While smoking-cessation apparently reduced the risk of adverse pregnancy outcome, smoking-reduction as measured by cigarettes smoked per day did not. The mothers who reduced cigarette-smoking from one or more packs per day in the first pregnancy outcom e to less than a pack per day in the second had similar second pregnancy outcomes to those who smoked a pack or more per day in the second pregnancy. This may be because of greater inhalation of nicotine, etc. per cigarette.2

In summary, this study clearly demonstrates the benefits of smoking-cessation between pregnancies. Smoking-cessation during pregnancy has proved to be rather difficult possibly because of time constraints.2 With an average of 3 years between most pregnancies, there is greater time for smoking cessation programs to break the nicotine addiction. Mothers who smoke in one pregnancy therefore represent a good target group for smoking-cessation. Non-black smoking women whose first pregnancy occurred before age 20 are a particularly good target group for intervention.

References:

1Stockbauer, J.W., Land, G. H. Changes in characteristics of women who smoke during pregnancy: Missouri 1978-1988. *Public Health Reports* 1991; 106:52-58.

2Benowitz, N.C., Jacob, P., Kozowski, L. T., Yt, L. Influence of smoking fewer cigarettes on exposure to tar, nicotine and carbon monoxide. *New England Journal of Medicine* 1986; 315: 1310-1313.

3Kendrick, J.S., Zahniser, C., Miller, N., Salas, N., Stine, J., Gargiullo, P.M., et. al. Integrating smoking cessation into routine public prenatal care: the smoking cessation in pregnancy project. *American Journal of Public Health* 1 995; 85: 217-222.

Note: This is a condensed version of the following article: Schramm, Wayne F., "Smoking during pregnancy: Missouri longitudinal study". *Paediatric and Perinatal Epidemiology*, Vol. 11 Supplement 1, January 1997 , pp.73-83.

Table 1

Percentage of Women Smoking Cigarettes in First and Second Pregnancies by Selected Characteristics

Smoking status			*Mother <20 in 1st Pregnancy*		*Mother >20 in 1st Pregnancy*		*Fetal or Infant Death in 1st Pregnancy*	
1st pregnancy	*2nd pregnancy*	*Total*	*Black*	*Non-black*	*Black*	*Non-black*	*Yes*	*No*
None	None	68.4	67.5	50.3	67.2	74.7	62.0	68.5
Smoked	None	4.3	3.0	5.1	4.5	4.1	7.3	4.2
None	Smoked	5.9	10.7	10.7	5.1	3.7	5.6	5.9
Smoked	Smoked	21.5	18.8	33.9	23.1	17.5	25.1	21.4
Smoked in 1st pregnancy		25.8	21.9	39.0	27.7	21.6	32.4	25.6
Smoked in 2nd pregnancy		27.4	29.5	44.6	28.2	21.2	30.7	27.3
n=100 percent		176,843	13,224	38,967	9,130	115,503	2,729	174,114

Note: All changes between first and second pregnancies are statistically significant at 0.05 level using McNemar's test except for black mothers >20 in first pregnancy.

Table 2

Relative Risks of Smoking Status in First and Second Pregnancies on Low Birth Weight (LBW <2,500 grams) Small-for-Gestational Age (SGA) and Fetal and Infant Mortality by Type in Second Pregnancy (with Non- Smoking in Both Pregnancies the Referent Group)

Smoking status						
1st pregnancy	*2nd pregnancy*	*LBW*	*SGA*	*Fetal Death*	*Neonatal Death*	*Postneonatal Death*
Smoked	None	0.97	1.18*	1.11	0.89	1.26
None	Smoked	1.82*	1.96*	1.16	1.04	1.60*
Smoked	Smoked	1.87*	2.31*	1.19*	1.37*	1.90*

Adjusted Relative Risks calculated using multivariate logistic regression with the following covariates: race, education, and age of mother, marital status in each pregnancy, spacing since last birth, year of birth and gender. SGA and LBW were also adjusted for birthweight of first birth and second order pregnancy weight of mother. The four death indicators were also adjusted for previous fetal or infant death.

*95 percent confidence interval does not overlap one.

Table 3

Relative Risk of Smoking Levels in First and Second Pregnancies on LBW, SGA and Perinatal Death in Second Pregnancy (with Non-Smoking in Both Pregnancies as the Referent Group)

Smoking level						
1st pregnancy	*2nd pregnancy*	*LBW*	*SGA*	*Fetal Death*	*Neonatal Death*	*Postneonatal Death*
<1pk per day	None	0.95	1.17*	1.11	0.92	1.39
>1 pk per day	None	1.09	1.24*	1.06	0.78	0.68
None	<1pk per day	1.65*	1.80*	0.95	0.99	1.52*
<1 pk per day	<1 pk per day	1.69*	2.05*	1.22	1.25	1.89*
>1 pk per day	<1 pk per day	2.08*	2.48*	1.32	1.65	1.56
None	>1 pk per day	2.52*	2.58*	1.79*	1.24	1.73*
<1 pk per day	>1 pk per day	2.05*	2.59*	0.69	1.45*	2.02*
>1 pk per day	>1 pk per day	2.06*	2.60*	1.38*	1.42*	1.85*

Relative Risks calculated using multivariate logistic regression with the following covariates: race, education and age of mother, marital status in each pregnancy, spacing since last birth, year of birth and gender. SGA and L BW were also adjusted for birth weight of first birth and second birth prepregnancy weight of mother. The four death indicators were also adjusted for previous fetal or infant death.

*95 percent Confidence Interval does not overlap one.

Provisional Vital Statistics for November 1996

Live births decreased sharply in November as 5,063 Missourians were born compared with 6,816 one year earlier. Irregular reporting is the primary reason for this sharp decrease.

Cumulative births for the 11- and 12-month periods ending with November also show a decrease, but this too may be due to irregular reporting.

Deaths decreased for all three time periods shown below. For January-November, deaths decreased 1 percent from 49,860 to 49,348

The **Natural increase** for Missouri in November was 981 (5,063 births minus 4,082 deaths). For January-November, the natural increase rate was the same for 1995 and 1996, 3.9 per 1,000 population.

Marriages increased in November, but decreased slightly for the cumulative months ending with November.

Dissolutions of marriage decreased in November, but increased for the cumulative periods ending with November.

The **Infant death** rate shows virtually no change for the three time periods shown below.

PROVISIONAL RESIDENT VITAL STATISTICS FOR THE STATE OF MISSOURI

	November				Jan.-Nov. cumulative				12 months ending with November				
Item	Number		Rate*		Number		Rate*		Number			Rate*	
	1995	1996	1995	1996	1995	1996	1995	1996	1995	1996	1994	1995	1996
Live Births	6,816	5,063	15.7	12.4	68,923	68,144	14.1	14.0	74,404	72,796	14.2	14.0	13.6
Deaths	4,979	4,082	11.4	10.0	49,860	49,348	10.2	10.1	54,121	53,357	10.2	10.2	10.0
Natural increase	1,837	981	4.2	2.4	19,063	18,796	3.9	3.9	20,283	19,439	4.0	3.8	3.6
Marriages	2,989	2,993	6.9	7.3	41,765	41,565	8.6	8.5	45,003	44,857	8.5	8.5	8.4
Dissolutions	2,080	1,939	4.8	4.7	23,663	24,273	4.9	5.0	25,797	26,336	5.0	4.8	4.9
Infant deaths	58	53	8.5	8.5	515	521	7.5	7.5	568	559	8.0	7.6	7.7
Population base (in thousands)	...	...	5,324	5,352	...	...	5,324	5,352	...	...	5,271	5,316	5,347

*Rates for live births, deaths, natural increase, marriages and dissolutions are computed on the number per 1000 estimated population. The infant death rate is based on the number of infant deaths per 1000 live births. Rates are adjusted to account for varying lengths of monthly reporting periods.

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